TROPICAL AGRICULTURE

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ELASTICITY OF DEMAND.

A SOMEWHAT notable circumstance attendant on the production of sugar and several other tropical products, is that fluctuations in the market values, although they may seriously affect the grower, are to a large extent imperceptible on the side of the consumer. Thus, in a general way, while the decline of twenty-five cents per 100 lb. in the world's market price of sugar may be of very serious consequence to the producer, it will scarcely affect the retail price for sugar unless the decline persists and therefore ceases to be a fluctuation. In this connection it is important to realise that sugar, as such, generally goes to the consumer in remarkably small quantities compared with those in which it is produced, and that in the ordinary way it is, and is always likely to be a relatively cheap commodity. The result is that it is very difficult to pass on fluctuations in value to the consumer owing to the limit to the divisibility of currency units. There are occasions, however, when this difficulty is unfairly circumvented by using the farthing or the cent as the equivalent of a fraction or part of these coins. Theoretically the matter might be obviated by retailing larger quantities, but this would be a domestic encumbrance besides depriving distributors of their trade. Moreover a procedure of this sort would not lead to greatly increased consumption of sugar as sugar, on account of the fundamental phenomenon of elasticity of demand. To explain exactly what is meant by this term it may be well to observe that one universal characteristic of human nature is the circumstance that a person's desire for any commodity, diminishes other things being equal, with every increase in his supply of it. The rate of diminution may be rapid or it may be slow; the consumer may be easily satisfied or satisfied only after increased consumption. If, under existing conditions, he is easily satiated, then a small decline in the retail price of the commodity will cause only a slight increase in his purchases, and the converse will be the case if he is satisfied only slowly. Under the former circumstances, the elasticity of demand is small; in the latter case it is considerable. It follows naturally, that when a demand is elastic for a fall in price it is also elastic for the opposite rise. It will be remembered that in Great Britain before the war that the price of sugar owing to its cheapness and plentiful supply was not elastic, though in the eighteenth century when this commodity was in a measure a luxury the reverse was the case. To-day the principle of inelasticity holds good for a commodity like salt, of which the price is relatively so low as to cause few people to consider its value, and the majority would use almost as much if the price rose a little as they do under present circumstances. In India, however, the price of salt is relatively high, and in consequence the demand there is moderately elastic. In connection with these ideas we must consider the phenomenon of marginal utility which is very clearly demonstrated in respect of such an article as water. If the supply is strictly limited, man consumes water first only for drinking; with greater supplies it will be used for washing as well; while with a copious supply he may water his garden and even find it necessary to get rid of the surplus by drainage. In pursuance of these ideas the question often arises as to whether the price of an agricultural commodity ought to be kept at a low and fixed rate, especially when its supply as agricultural produce must vary. In this connection it is interesting to notice that very perishable produce like fruit and meat, the current supply price must be adjusted in such a way as to create an elastic demand in order to check waste during times of over-production. This consideration leads to the subject of other uses of certain kind of raw material besides those of direct consumption.

In regard to sugar, there is an enormous demand for this commodity for preserving and for confectionery purposes, and in this direction there exists very considerable elasticity of demand. In times of over-production of sugar it is through avenues like these that the pressure would seem most easily to be relieved. The demand for sweet-meats for instance, is proverbially elastic but a point is inevitably reached when the consumer gets sick; but the effect of increasing the quantity at the usual price is usually in the case of sweet-meats like chocolate, to attract a larger number of purchasers and to effect a bigger total consumption. In this connection it must be remembered that the sale of one commodity in a manufactured form is frequently limited by others, as for instance, sugar and cacao in the manufacture of chocolate and fruit and sugar in the production of jam, very strikingly seen in Australia where sugar is very expensive and fruit exceedingly cheap; consequently, a high range of prices for one commodity though accompanied by low values for a second one, may so counterbalance each other as to render the position a normal one to the manufacturer though extremely abnormal to the growers. In dealing with all questions concerning the demand of the consumer, it is generally easier to obtain a clearer notion of the circumstances of any case if one class of society be considered at a time. In regard to the consumption of sugar as such, the poorer classes may consume per head as much as the rich; but with commodities like meat, tobacco, tea and spirits, the elasticity of demand increases rapidly as one descends from rich to poor. And an interesting factor which will be seen to enter into the subject here is that of grade and brand. The eflections already expressed in regard to the demand for sugar will be understood to have reference to the regular consumers of one grade, though some elasticity of demand will be found to exist in connection with various qualities of this article. Quality, indeed, is intimately associated with elasticity of demand. Even amongst the rich an elastic demand can be created by grade, brand and especially by novelty. But this often depends upon the existing degree of sensibility; some people care little for refined flavours or a distinctive appearance provided they can get plenty of any particular commodity. The chief cause of elasticity of demand amongst the rich is perhaps the desire to obtain or to monopolise luxuries for purposes of display and social distinction—a desire which is practically insatiable. This feature of modern civilization is an important factor in manufacturing industries which depend on the production of grapes, tobacco, cotton, silk, tea and rubber, and is actually potent in the respective systems of cultivation, as for example in the production of light-coloured rubber irrespective of its strength. Concerning elasticity of demand amongst primitive people statistics show that amongst the Africans the demand for clothing is becoming rapidly elastic though in this case it is largely a question of the actual existence of monetary wealth which allows of the elasticity taking effect. The main point in connection with the subject which affects tropical agriculture is the importance of taking care not to over-produce those commodities in connection with which there is but little elasticity of demand. Cacao and sugar as such belong in a general way to this category though these commodities in combination with themselves and other substances are capable of producing products for which the public will rapidly consume more if the price becomes lowered. The whole question of demand is extremely complicated and is partly physical and partly psychological. It is the *saturation* of the consumer with which we are mainly concerned and assuming the existence of adequate supplies, it is really the steepness or slope of a curve of consumption per head from a point of very high value to an extreme of very low value that gives in a general way the measure of elasticity.

THE WORLD'S TOBACCO INDUSTRY

The present world-wide and almost universal custom of smoking tobacco had its origin, like the tobacco plant itself, in latitudinal-tropical America apparently in the Peruvian region, amongst the Incas. Tobacco was first chewed, but smoking had originated and had spread to southern Brazil and north to southern Canada before the European discovery of America by Columbus in 1492.

The smoking of tobacco has now become a fixed psychological necessity, and extraordinary differentiation and specialization have been brought about through taste discrimination and the special soil and climatic requirements needed for producing certain types of the tobacco plant. Commercially the tobacco trade is characterised by its manifold brands and its financial monopoly. If one generalisation more than another can be applied to the industry as a whole it is that, from the growing of the leaf to the selling of the brand there is a remarkable element of specialization. On the other hand, in spite of this specialization, the industry is characterised by its world-wide distribution and ramifications. No other economic plant has such a wide geographical range as *Nicotiana tobaccum* and no custom is more widely practised than that of smoking. But just as there are smokers and smokers so there are tobaccos and tobaccos and tobacco soils and tobacco soils. Nevertheless the best quality and largest quantity of tobacco is grown in fairly well-defined regions of the world and the manufacture of and trade in this tobacco is largely restricted to certain centres and commercial interests.

Centres of Production.—The world's principal tobacco-growing country is the United States of America which is now producing about 1,200,000,000 lb. from about 1,500,000 acres. India is supposed to have 1,000,000 acres under tobacco yielding about 500,000,000 lbs. most of

which, but not all, is of low grade and principally consumed within the country. The next most important tobacco-producing country is Sumatra which, in 1922 exported 324,324,000 lb. and the output for 1923 was to be restricted to this amount. Java, in 1922, exported 35,161,280 lb. In regard to Africa, the Union of South Africa is an important tobacco-producing country though it is in Rhodesia and Nyasaland that the most interesting development has taken place from the standpoint of the British Empire. Rhodesia in 1922-23 produced 2,770,000 lb., and Nyasaland, in 1920-21, 4,970,000 lb. In the New World, Cuba in 1922 exported about 15,000,000 lb. of tobacco comprising 38,725 bales, 91,831,749 cigars and 21,077,054 "cartons" of cigarettes. Other important tobacco-producing countries are Japan, the Philippines, Brazil and China which between them apparently produce about 778,000,000 lb. giving the world's total production of tobacco in 1922 as 2,850,000,000 lb. approximately.*

Conditions of Production.—Most of the world's tobacco is grown within 40° north and south of the Equator. The plant is influenced in respect of quality, by conditions of soil and climate, to a phenomenal extent. Generally speaking, the best tobacco grows on the poorer soils of semi-tropical regions. In its cultivation the tobacco plant requires a great deal of labour and special attention at certain periods of the year. In the south-eastern States of America, which is the great tobacco belt of the world, the four main cost-items or groups of items are topping, worming, suckering and spraying; harvesting; curing; stripping and marketing: the last named together with harvesting being much greater than the cost of planting and cultivation. In America it is essential to remember that tobacco is grown on a family basis, on small areas of from 10 to 50 acres. This also holds good in respect of Cuba and in the large Eastern continental countries like India and China which have an enormous indigenous peasant population and a local consumption of the tobacco produced. In Sumatra, however, the large tobacco plantations are in charge of "Administrators" the whole being under a "Chief Administrator." Cheap but selected labour is employed in large quantity both in the field and curing houses of the Dutch East Indies. It may be mentioned that in Java tobacco plantations are being rapidly converted into sugar estates. An important feature of tobacco production is that it is one of the most expensive crops to grow and has probably of all crops the highest acre value. It is also a very speculative crop except under very special circumstances, for weather conditions can easily inflict severe losses. For this and other reasons tobacco is sometimes grown under cheese-cloth. There are also several severe pests and diseases of tobacco, the most serious of which appear to be root disease and mosaic. As regards yield, manuring has to be adopted with great caution in order to preserve that chemical composition of the leaf on which quality depends. Too much manuring increases yield at the expense of quality and hence reduces profit per lb. The nature of soil influence on the tobacco plant will be found discussed in "Tropical Agriculture" for May, p. 69.

Types of Tobacco.—In the retail trade and amongst consumers "tobacco" is divided up into Pipe Tobacco, Cigarettes, Cigars and Plug. As we shall see later, this governs manufacturing policy. But at the growing end and on the tobacco-leaf market, tobacco in the U.S.A., is divided into types having the following designations: (1) Dark Fire-cured (the old original Virginia for plug and chewing); (2) Bright Flue-cured (tobacco for "Virginian" cigarettes and some pipe tobacco); (3) Cigar Leaf—largely but not entirely grown in the tropics; (4) White Burley (for sweetened plug, chewing and blending). "Turkish," "Latakia" and Chinese tobaccos may be considered as special classes by themselves. The most striking feature in the production of all these types during the last twenty years has been the phenomenal increase in the production of (2), particularly in the United States, India, Rhodesia and Nyasaland. But the above-mentioned types in America are sub-divided into sub-types, families, qualities, colours, lengths or sizes. An account of this highly technical classification will be found in the regulations of the Tobacco Growers' Association of Virginia and North and South Carolina, in the case of Bright Flue-cured tobacco; and in the regulations adopted in Kentucky, by the Dark Tobacco Growers' Co-operative Association, in respect of this heavier type. It will be evident therefore that if the price of tobacco in the American market is needed, one must either secure an average for all grades or else refer to a definite grade *e.g.*, "Flue-cured Tobacco, Sub-type 1, Family A, Quality 1, Colour O, Long." These grades may range from a few cents to $1 per lb. Information is not available in regard to the system adopted in Sumatra but it may be mentioned that the wrapper leaf is scientifically graded, and that while some of it is exported to the United States the bulk of it goes to Holland. In Cuba the grading has reference principally to cigars of which the Corona grade has a world-wide reputation of high excellence. Cigar bands may possess no definite commercial significance. There are many thousands of these, some of which are simply printed for the benefit of special customers who desire this form of "exclusiveness" for purposes of social distinction.

* The figures in this paragraph have been abstracted from the Year Book of the United States Department of Agriculture for 1922, from recent Reports of the British Department of Overseas Trade on economic conditions in Cuba and the Dutch East Indies, from crop statistics in the *Rhodesian Agricultural Journal* and from the Official Handbook of Nyasaland and other sources including Blue Books. Some of the information in subsequent paragraphs was obtained personally by the writer when visiting Washington D.C., Havana and Bristol.

Commerce.—One of the best ways of securing an insight into the commerce of a vegetable product like tobacco, is to place oneself in the position of a customer who has just purchased, say a tin of 50, of any well known brand of (English) Virginian cigarettes, and to consider from consumption backwards the economic life-history of the purchased unit. In the case of an overseas colony like Trinidad, a tin of 50 cigarettes of good brand will cost to-day 30*d.* and it will contain about 2 ounces of bright tobacco, which on the farm where it was grown and cured in Virginia or Carolina was probably sold between 1917 and 1921 at the general average price of 26·4 cents (13·2*d.* per lb.) Thus a pound of cigarettes in Trinidad sells for 20*s.* whereas the tobacco in it might have been bought from the farmer for 1*s.* 2*d.*, or seventeen times less than the retail price of what is essentially paid for. What are the reasons which justify or go to explain this difference? It is clearly impossible in the present article to give anything but the briefest of explanations. Obviously in the first instance the retailer has to make a profit for his service in stocking and selling the cigarettes in small quantities; there is also probably a local Distributing Agent to be paid; and in addition, an import duty of 15 per cent. imposed by the local Government. Regarding the ocean shipping charges as the manufacturers' cost (which, like all costs, is passed on to the consumer), we arrive at a principal centre of manufacture say, in Bristol. There, in a huge factory employing thousands of hands with a dining hall capable of seating 1,400 employees at a time, one can observe the evolution of our tin of 50, which involves at least nine principal processes. First in the leaf room, at the top of the factory, the cylindrical hogsheads of bright tobaccos, which have been stored for several years in order that the leaves may mature are selected; then, passing into manufacture proper, the leaf goes through the following processes: (*a*) breaking and wetting (by steam and machinery) (*b*) stemming, (*c*) shredding, (*d*) pressing, (*e*) heating and high pressing. Then comes the astonishingly ingenious manufacture of the cigarette itself into long "pipe" lengths many yards in extent, which, by appropriate machinery is cut into the usual cigarette lengths. These are next conveyed mechanically into the tins which are again by machinery soldered down, punctured, exhausted of air, resoldered and labelled ready for packing in wooded cases for export in enormous quantities to every corner of the earth. But before the tobacco can be drawn out of bond for utilization in this Bristol factory the British Customs duty of 8*s.* 2½*d.* per 100 lb. of unmanufactured tobacco containing less han 10 lb. of moisture has to be paid. Here it will be noticed how important the moisture content must be as well the economic utilisation of the offal or waste in the course of factory operations. The tobacco thus brought from the warehouse in Bristol has been imported most probably from America where it has been purchased at the Virginian or Carolina auctions or on the farms or in the warehouses* by British buyers sent there at certain periods of the year. Naturally this marketing of the leaf has to be paid for and in addition, the railage, handling and shipping charges from America to England. If we include the large expenditures at the factory end on advertising and the interest charges and many other items of a more indirect nature, it will be realised that a tin of 50 cigarettes is a unit which, in the course of its economic journey, has constantly been accumulating fresh values. As to whether the retail selling price of 2*s.* 6*d.* which we started with, bears a reasonable relation to the accumulated cost, is difficult to determine. There is no doubt, however, that this information is in the hands of the manufacturers whose organisations include a highly efficient statistical department.

Monopoly and Taxation.—The economic life-history of cigars and pipe tobacco are in many respects similar in principle though in the case of cigars a great deal of the manufacturing is done in the same country in which the wrapper leaf and fillings are produced. As we have seen in the case of Cuba and India, cigarettes are also produced under these conditions, but in a general way the world's commercial brands of cigarettes, pipe tobaccos and cigars are centrally controlled. It is probably correct to say that the organized tobacco trade of the world is entirely in the hands of one huge combine consisting of three great Companies. The first and greatest is the Imperial Tobacco Company which controls the tobacco trade of the United Kingdom and Canada, the second is the American Tobacco Company which has agreed to look after the trade of the United States, and the third is the Anglo-American Tobacco Company which controls trade in the remaining countries of the world. There are exceptions as in Ulster, but seldom does a tobacco manufacturing industry spring up in any country without eventually passing into the hands of this great combine. Economically this has its advantage and disadvantages. It certainly ensures uniformity and continuity of distribution and to some extent cheapness which is usually associated with mass production. At the same time the dividends of the Imperial Tobacco Company show the vast profits made by the trade. It cannot be too strongly emphasized also that the tobacco industry is essentially a revenue-producing industry and is therefore of the highest political and economic importance. It is worth noting that a commodity like tobacco which is not a physical necessity is still consumed in increasing quantities in spite of the burden which it has to bear in respect of tariff impositions. The inveterate smoker is of all consumers the most altruistic, and the application of this remark is no longer restricted to one sex.

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* *See* Regulations under the United States Warehouse Act, of August 11, 1916, issued November 15, 1920, for Tobacco Warehouses: Office of Secretary of Agriculture, Circular 154.

It may prove useful in closing this article which is unavoidably incomplete, to mention the following trade publications dealing with tobacco that are quite distinct from the better known technical and scientific bulletins issued by experiment stations in tobacco-growing countries. The journals are: (1) "Tobacco" 10 East 39th Street, New York City; (2) "United States Tobacco Journal" 146, Water Street, New York City; (3) "Tobacco Trade Review" Eastcheap Building, London, E.C., England. These together with Tobacco Company and other reports in the newspapers should be perused by those interested in the commercial aspects of the tobacco industry.

W. R. DUNLOP.

PLANTATION PALM OIL.

[*In the March issue of "Tropical Agriculture" an article appeared on plantation palm oil developments in Sumatra. The following extract furnishes information concerning the attention which is being given to this subject in the Federated Malay States, taken from an article by B. Bunting and C. D. V. Georg in the "Malayan Agricultural Journal," June-July,* 1924.]

The present London quotations (March 1924) for oil palm products are approximately as follows:—Palm oil (Lagos), £40 5*s.* 0*d.* per ton; Palm kernels, £20 0*s.* 0*d.* per ton; Palm kernel oil, £45 0*s.* 0*d.* per ton; Palm kernel cake £7 0*s.*0*d.* per ton.

The quotation for Lagos palm oil applies to an oil with a free fatty acid content of 18 per cent. calculated as palmitic acid. A premium of 1*s.* 9*d* is paid for each per cent. of acidity below the standard, thus a premium of 15 × 1*s.* 9*d.*=£1 6*s.* 3*d.* per ton extra would be paid for an oil of only 3 per cent. acidity. It is possible with careful preparation to keep the acidity of palm oil, produced under plantation conditions, within this limit. This premium for palm oil having a low free fatty acid content was based on the native prepared oil received in the European markets from Africa and is not commensurate with the extra expense involved in the production of such a high grade product as can be prepared under plantation conditions. It is understood that the revision of this premium is at present under consideration.

From actual experience gained in the cultivation of the oil palm in this country, it is considered that this is a crop well worth development on a plantation scale. The yields recorded locally are sufficiently promising to warrant the outlay of further capital for this industry, and it is considered that the return on the capital invested will undoubtedly be greater than that obtained from the cultivation of coconuts. In this connection the details given below, comparing the returns which may be expected under normal conditions from both coconuts and oil palm in full bearing may be of interest. It should be borne in mind that the estimates for the African oil palm are based on figures previously given and are therefore a forecast, since there is no plantation in this country on which the palms are in full bearing.

Returns from Coconuts.—A good coconut plantation in full bearing should produce an average of 60 nuts per palm per annum, which, with 55 palms per acre, will give 3,300 nuts per acre per annum, equivalent to a yield of 16 cwt. of copra per annum.

The actual return from 1 acre of coconuts at current prices would therefore be as follows:—
16 cwt. of Copra at £29 10*s.* 0*d.* per ton—£23 12*s.*0*d.*

Returns from Oil Palm.—Reference to the table previously given will show that the estimated yield from palms in full bearing, allowing only 85 per cent. extraction of the theoretical figure for the oil content, is approximately 18¾ cwt. of palm oil and 5 cwt. of kernels per acre per annum.

The actual return from 1 acre of oil palms at current prices would therefore be as follows:—

18¾ cwt. of Palm oil at £40 5*s.* 0*d.* per ton	£ 37	14*s.* 8*d.*
Add premium at 1*s.* 9*d.* for 3% acidity	1	4*s.* 6*d.*
5 cwt. of Palm kernel at £20 0*s.* 0*d.* per ton	5	0*s.* 0*d.*
	£43	19*s.* 2*d.*

Although the return from Palm oil is considerably greater than that from coconuts exported as copra, it must be remembered that both the preparation of the Palm oil and the extraction of the kernels involve a heavy outlay for plant and machinery. This additional expense must therefore be taken into account when making a fair comparison, since no machinery is required for the preparation of copra.

A NEW USE FOR CACAO.—In times of overproduction of an agricultural product or of low prices and sluggish market, the development of new ways of using up material has often proved of great help to the industry. The investigations along this line by the rubber industries since 1913, have been fruitful of results. For several years now the cacao market has been depressed and it would appear that a possible new use for cacao, which may in the future considerably increase its consumption, has been found in the development of the cacao bread. The United States Department of Agriculture carried out experiments which resulted in a bread being prepared in which from 8 to 10 per cent. of the flour used was substituted by cacao powder, and the shortening usually supplied was omitted, as this is supplied by the cacao, presumably by the fat which it contains. This bread has now been manufactured in Trinidad according to the United States recipe and has been pronounced by many who have tried it to be very palatable and likely to meet with some demand. If such a demand became general the consumption of cacao might be increased.

PINEAPPLES IN THE STRAITS SETTLEMENTS.

[*In "Tropical Agriculture" for June there appeared an article on the World's Pineapple Industry. The following article, in continuation, supplies particular information in regard to the Straits Settlements, and is taken from the new Malayan Agricultural Handbook.*]

In the Malay Peninsula the pineapple is grown both for dessert and canning purposes; the largest planted areas are to be found in the Island of Singapore, where there are several large canneries engaged in the preserving of the fruit. The local industry is very large, as will be seen from the following figures which show the exports from Singapore during the past three years.

	Quantities. *Cases.*	*Value.* $
Exports, 1919 ..	255,873	3,286,001
Do. 1920 ..	446,890	7,117,976
Do. 1921 ..	662,360	6,210,383

The rise in the value of exports in 1920 was due partly to the revival of trade, immediately after the war, and partly to the fact that supplies of tin plate, practically unobtainable during the war, were more available. The principal country for export is the United Kingdom, but Canada, British India and the United States of America absorb fairly large stocks.

Cultivation for Canning.—The variety most commonly grown for canning is a "Queen" type of pine, which is very similar to the "Red Jamaican Pine" of the West Indies. The fruit is very small, weighing from 3 to 5 lbs. and has an excellent flavour when tinned. The "Mauritius" and the "Smooth Cayenne" or "Kew Pine" are chiefly grown for dessert purposes.

Although the pineapple will grow on most soils, provided they are well-drained, it usually thrives best on the stiff clay types of soil. A rich soil appears to be unsuitable as it tends to develop the size of the fruit at the expense of the flavour. Pines grown on some of the poorest Singapore soils have the best flavour when canned.

Planting.—The pines are propagated usually from the suckers which are obtained from the base of the fruit, the suckers being allowed to dry slightly in the sun before planting. They can be propagated also by means of the off-shoots or suckers from among the lower leaves of the plants. A common method of planting is in rows 5 feet apart, the plants being spaced 2½ feet apart in the rows, with a 6-foot path at every 100 feet. About 3,000 suckers are required to plant up an acre.

After planting, the fields require careful weeding, but are not generally manured. Fortunately the pineapple has few insect enemies and is not subject to many diseases.

Yield of Fruit.—The pines begin to fruit at from 12 to 18 months, and during the first year of fruiting will produce one fruit per plant; but, with good cultivation, they should produce an average of about two fruits to each plant every year after the first year of fruiting. Under ordinary conditions, the average yield of pines is about 4,000 to 5,000 per acre per annum. There are usually two main crops during the year, the first in May and June and the second in November and December, but the crops depend very much on rainfall. When there is a spell of dry weather of long duration the pines do not fruit.

A properly cared-for estate, as cultivated in the Straits Settlements, will produce good fruits for 5 to 6 years, after which the pines gradually become smaller, and it is usually found necessary to remove the old plants and replant strong fresh suckers.

Canning.—The pineapple canning or tinning industry is in the hands of Chinese merchants. In the Straits Settlements, the pines are always peeled and cut by hand, as hand labour is found to be more economical. The peeler wears a rubber glove on the left hand as a protection from the juice of the fruit. After peeling, the pines either whole, in slices or in cubes are placed in tins, which are filled either with water or syrup. In the case of whole pines, the cores are removed previously, if required, by a tin tube which is pressed through the centre, but most pines are tinned without coring. The syrup consists of about 3 parts of sugar to 100 parts of water, but is varied with the ripeness of the fruit. After the pine is put into the tin, the tin is soldered up and a number of tins are placed on a wooden rack slung on wires and plunged into a rectangular tank of water heated by means of steam-coils. The tins are boiled in this tank for ten to fifteen minutes in the case of the smallest tins, and up to an hour for large tins, the biggest tins weighing 5 pounds when full. After removal from the boiling water a puncture is made in the top of the tin with a hammer and punch; in large tins two punctures are made. This is done to allow the steam to escape; the holes are resoldered and the tins plunged again into boiling water for about nine minutes. They are then labelled and packed in boxes for export.

The forms manufactured for export are (1) whole pines, (2) sliced pines, and (3) chunks or cubes. The most popular size is the 1½ lb. tin, which is shipped in wooden cases containing 4 dozen tins.

Machinery.—The greater part of the machinery employed in the canning factories is necessary for the manufacture of tins, and consists of tin plate cutting machines, cover and bottom presses, and rolling machines for making the tins. The tin plate is imported from the United Kingdom and the tins made completely in the canning factories in Singapore.

General.—Owing to the main crop maturing in two comparatively short seasons during the year, the working of the factories is very irregular and it is necessary to employ much additional labour during the height of the fruiting seasons. The prices paid for pines are somewhat high at the beginning and end of the seasons, but they are, as a rule, so low during the height of the May-June crop that the grower gets practically no profit.

There is usually a small supply of fruit available between the main cropping seasons, and the canner has to rely on this to keep his factory running during these periods. The supplies are usually supplemented by purchasing fruit from outside sources where the fruiting season does not coincide with that in Singapore, and fairly large quantities are shipped to Singapore from Port Swettenham : when it has to be transported such long distances, the fruit is cut just a little under-ripe. Towards the end of 1921 there existed about six canning factories in Singapore, two near Johore Bharu on the mainland, and one in Selangor.

THE CONTROL OF PESTS BY NATURAL ENEMIES.

The control of pests by natural enemies is a phase of economic entomology which has for several years been very much practised, and which has already yielded results of importance.

The moth borer of the sugar-cane which was introduced from the West Indies into Louisiana where it has become a serious pest, is an example of recent work along that line. Attempts are being made to transport to Louisiana from Cuba and Porto Rico a parasitic fly which is expected to exercise a controlling influence on the pest. A similar attempt is being made by a firm in British Guiana to introduce this fly from Porto Rico as an enemy of the moth borer in that colony.

An interesting attempt is now being made to introduce natural enemies of a plant pest. The prickly pear has been for some years a very serious pest in Australia, and according to an article in the *Journal of Economic Entomology*, August, 1924, an attempt is being made to transport from North America some of its insect and other natural enemies.

As the prickly pear is a native of America, the Australian Government has looked to this part of the world for the enemies of the plant which should assist in its biological control.

Mr. John C. Hamlin, the author of the article, gives an account of the precautions that are necessary to be taken and of the elaborate work which needs to be done in connection with a project of this sort.

It has been necessary to study the life histories and habits of the various insects concerned, and as many of them are themselves subject to parasitism it is necessary to breed them in captivity for a period of time long enough to enable parasite-free material to be obtained.

It will be readily understood that in this work it will be necessary to determine the best conditions for maintaining a supply of cactus and for allowing for the feeding and breeding of its pests. It has also been necessary to learn by experience the best kind of containers for shipping the necessary living material to such a distant point as Australia.

Attempts are being made by most Governments to prevent the introduction of pests and diseases by means of quarantine and inspection services. Such introductions frequently occur and are extremely difficult to prevent. When, however, it becomes necessary to transport, and to introduce under satisfactory conditions, beneficial insects or fungi, very considerable expense is likely to be incurred and a very highly specialised technical knowledge must be employed.

PROBLEMS OF AGRICULTURAL PRODUCTION.

The *Scientific Monthly* for September, 1924, contains an article entitled "Adjusting agricultural production to changing conditions" by C. G. Williams, Director of the Ohio Agricultural Experiment Station.

Although this article is written with reference to the agricultural conditions in the United States, some of the points raised by the Author may be of interest to the Agriculturalist in the tropics. It is shown that in the last thirty years the farming population has changed from 57 per cent. in 1890 to 40 per cent. in 1920 with the result that the farmer finds himself in a country, the majority of whose inhabitants are engaged in pursuits other than agricultural.

Another change is to be found in the greatly increased agricultural output per man, which amounts to an average increase in the important staple crops of something over 50 per cent.

In the matter of prices, too, there has been a very considerable change. Taken with reference to an index figure based on average prices and values for the period 1910-14, the farm products values have ranged as high as 236 in 1919, and in 1923, were given as 144 as compared with the index figure of 100. The rate of wages has increased steadily until in 1923 the farmer is faced with the rate wage represented by the figure 215, and in the case of farm machinery with a figure of 165 as compared with the index figure of 100 in 1914.

The writer points out that such a situation calls for some adjustment on the part of the farmer, and asks whether he shall keep on growing the accustomed acreage of his staple crops and the usual numbers of animals on the farm.

It is suggested that for instance while some change in the crops produced may result in an improvement of the situation greater economy in production will materially help. It is pointed out that with the development of labour-saving implements and the better understanding of the use of fertilizers that the increase in the amount of crop produced per acre should be made at a cost which will allow for a considerably increased profit. It is also suggested that as an accompaniment of increased yield per acre, reduced acreages will in many instances be found to be a good economic policy. As a further aid to increased production the use of leguminous crops are recommended.

TROPICAL WORLD.

JAMAICA.

In many respects Jamaica differs greatly from the other British West Indian Islands, being in size the largest and containing the greatest total number of inhabitants. Its 800,000 people are almost entirely engaged in some branch of agriculture, principally cattle-raising, banana-growing, sugar-growing and other products including the world's highest standard of coffee. The largest individual areas of land are owned by the cattle-raising interests and these areas range from several thousand acres down to five or ten acres. The sugar estates are mostly cultivated in fifty to two hundred acre areas but there are several central factories including a new one in course of erection on the strength of British capital. Bananas and cacao and to a large extent, coffee, are industries based upon small peasant proprietorship. The average cacao estate is about thirty acres while the average banana holding is probably very much less. From the point of view of total production, cattle-raising, or pastoral industry, is the predominant industry of the island and has been so for very many years. A comparatively recent development has been the new Government sisal factory at Lititz which is now producing, and it may be of interest to mention that Mr. Cyril Connell who has been employed for some years at the Basse Terre Central Sugar factory in St. Kitts is now in charge of the sisal factory in Jamaica the only one of its kind in the British West Indies.

FRENCH WEST AFRICA.

The total value of the foreign trade of the French West African Colonies amounted in 1923 to 952,361,930 francs as compared with 662,862,130 francs in 1922, an increase of 43·5 per cent. The imports reached a value of 533,357,802 francs, while the exports amounted to 419,004,128 francs, as against 351,508,480 francs and 311,353,650 francs respectively in the previous year, and increase 51·7 per cent. in imports and 3·45 per cent. in exports. As regards exports from Senegal increases are recorded in regard to hides, wool, cotton and dried fish. As regards French Guinea an increase in the exports of all produce is to be noted but especially in regard to rubber, gold, cotton and dried hides. From the Ivory coast the exports of mahogany and building timber, palm products and the cacao mark a considerable advance over the quantities exported in 1922. From Dahomey there have been increased exports of palm kernels and oil while from the French Sudan the chief items of export were ground nuts, wool, cotton and dried hides. The exports from Haute Volta have consisted principally of slaughtered cattle exported to the British colonies of the Gold Coast and Nigeria. This last-mentioned fact is an interesting example of trade in produce between foreign colonies.

COLOMBIA.

It is common knowledge that bananas have for years been grown under irrigation in enormous quantities at Santa Marta. Last May, however, the agents of two fruit companies visited the valley of the Sinu with the object of discovering its suitability for banana cultivation on a larger scale. The agent of the Atlantic Fruit Company is reported to have said that only in Mexico had he seen lands equal in fertility and that the Company would soon establish a large banana zone along the Sinu. Mr. H. I. Heil, agent of the United Fruit Company, who was accompanied on his tour by Mr. Cabrales, commenced operations at once for establishing the banana industry in the Sinu valley. A meeting of landowners was called to enter into negotiations with the United Fruit Company. The outcome of this meeting was that the Company agreed to plant bananas for a distance of 100 kilometres from the mouth of the river Verde to within a certain distance of the banks of the Sinu, also to buy lands, and to advance the money for working the land to those who did not wish to sell. This is interesting in contrast to the attitude of fruit companies towards the West Indies (Lesser Antilles) at the present time. Concerning sugar, it is noteworthy that this commodity is very expensive in Colombia on account of the heavy import tax imposed on it. Unrefined sugar, sold in New York at 7 cents per lb. is sold at the rate of 12 cents in Barranquilla, while in Bogota and other towns in the interior the price is as high as 20 and 24 cents per lb.

ZANZIBAR.

The official report on the trade of Zanzibar for 1923 indicates continued improvement in the commerce of the island. The value of the external trade for the year was Rs. 63,350,945, being an increase of 7·7 per cent. over the previous year. The imports were valued at Rs. 29,144,767 and the exports at Rs. 34,206,178, nearly 12½ per cent. more than in 1922; this increase was due principally to heavier shipments of cloves, of which there was an unusually large crop. Cotton piece goods formed the most valuable imports, amounting in value to Rs. 8,500,000, of which goods to the value of Rs. 4,500,000, were exported. Rice and grain to the value of nearly Rs. 4,000,000, were also imported. Merchandise imported from the United Kingdom was valued at Rs. 6,123,789; from India and Burma, Rs. 7,193,789 (principally cotton goods and rice); from Tanganyika Rs. 4,372,632; and from Kenya, Rs. 2,167,701. The livestock trade in cattle, sheep and goats was principally carried on with Kenya, which exported stock to the value of Rs. 430,361. Although Kenya is able to export quantities of timber, Zanzibar still buys ten times more timber from Burma, Scandinavia, and Siam than from Kenya.

SOUTH INDIA.

The middle months of the current year appear to have been marked by the occurrence of extreme climatic conditions throughout the tropics and even in northern latitudes. As instances may be quoted the serious inundation reported from Formosa and the recent hurricanes not only in the West Indies but up the eastern coast of the United States. In addition to these there have recently been disastrous floods in southern India, notably Madras, and even Ceylon has not been exempt from abnormally heavy rainfall during the middle months of the year. In Madras where of all places damage has been most extensive, it would appear that Malabar, Travencore, Cochin and the Niljiris have suffered most. In Mysore a considerable area of European plantations producing coffee and rubber have been cut off through the collapse of bridges across the rivers and the high range of Travencore where there are large rubber and tea areas railway communication with the city of Travencore has been broken down. Breaches on the railway lines in Northern India have been general and losses in every respect have been very serious. In Travencore the loss of more than a hundred lives has been reported.

BELGIAN CONGO.

M. Henri Carton, Minister of Belgian Colonies, in addressing the Rubber and Tropical Products Conference in Brussels last April spoke appreciatively of the developmental work effected by the British and French in their tropical territories intimating the value of this work to Belgium in respect of the Congo. To-day Belgium capital is invested in rubber, tea, coffee, oil palm, sugar-cane, and allied industries in many foreign possessions but the most important developments have taken place in the Congo. In this territory the Belgian development began not in agriculture but in mineral products and in trading the natural products of the vast forests of this equatorial region. At the present time barbarism, slavery, internal warfare have been replaced by order, and in a country which is as big as half of Europe. A system of rivers, only equalled in the tropical zone by that of the Amazon, offers 12,000 kilometres of navigable waterways. The vast equatorial forests contain inexhaustable beds of copal of which 14,000 tons were produced in 1923. During the last four years the exports from the territory have included apart from copal 167,619 tons of palm nuts, and a million and a quarter kilos. of ivory. But much more astonishing has been the discovery of mineral riches. The beds of tin and copper in the south and centre of Katange are among the most important in the world. Coal is found in large quantities and iron is abundant, in the north as well as in the south. During the past year radium has been manufactured from minerals from this region in sufficient quantities to supply the world's requirements. Gold beds have been discovered in several regions and in the south in 1923 about 300,000 carats of diamonds were exported. Several railway schemes are in progress of operation, which eventually will lead to the development of agriculture. The success that is likely to be achieved will be due largely to the utilization of the experiences gained by Great Britain. Already the Belgium Congo owes a debt of gratitude to the British Cotton Growing Association, and to the enterprise of Lord Leverhulme in respect of organizing the palm oil industry and the development in places of the oil palm on a plantation basis.

THE LESSER ANTILLES.

The months of July, August and September are from the standpoint of agricultural industry, relatively quiet months in the West Indies. They constitute the period of greatest rainfall and therefore the main growing season in respect of both sugar-cane and cacao. The cotton seasons, however, are somewhat different. In St. Vincent cotton is planted in June or July and picked in December or January ; in St. Kitts and Montserrat cotton is planted in March or April and picked in August or September. This year unfortunately the cotton crop of Montserrat and St. Kitts, and in the latter island cane as well, to some extent, have been seriously damaged by the hurricane which swept across these islands at the end of August. In Montserrat according to telegrams most of the cotton crop has been destroyed, while in addition, 40 people have been killed and a larger number injured. This is the first seriously destructive hurricane in Montserrat for twenty-five years. Trinidad lies just south of the hurricane track and is therefore specially favoured in respect of the absence of high winds.

CHINA.

From an article on the sugar industry of China by Mr. S. Hori of Japan, which appeared in the August number of the *International Sugar Journal*, we learn that the present production of sugar in China is roughly estimated at 4,500,000 piculs (about 267,800 tons) and the amount imported annually at 5,188,000 piculs (about 208,800 tons) the total being 9,688,000 piculs. This amount averages a consumption of 3·22 lb. of sugar per head of population. The demand is steadily increasing and 99 per cent. of the sugar consumed is cane sugar. The province of Szechwan, which produces nearly 65 per cent. of the sugar consumed in China is likely to become one of the greatest sugar producing districts ; the fertility of its soil, its warm climate and large population (40 millions) guaranteeing its pre-eminence in this respect. The provinces of Kiangsi, Fukien, Kwangsi and Kwantung, with an aggregate area of 300,000 square miles and population of 62 millions, are most suitable, both as regards soil and climate for the cultivation of sugar-cane. There are, however, many difficulties to be encountered in bringing these districts up to the general level of improvement.

POSITION OF FIBRE PRODUCTION.

[*The following article is a continuation of Dr. E. Goulding's paper read at the Brussels Conference last April. The first portion appeared in "Tropical Agriculture" for September.*]

Nigeria.—The Sisal agave has been grown on a small scale by the Department of Agriculture at Ilorin and at Old Calabar, and the results have proved that the cultivation can be carried on satisfactorily. It was stated, however, by the Director of Agriculture of the Northern Provinces (Mr. P. H. Lamb) in 1919 that as the production of Sisal hemp on a commercial scale is adapted to large planters rather than to the small cultivator it is unlikely that any considerable development will take place.

Sierra Leone.—Trials have also been carried out successfully in Sierra Leone and a sample of fibre which was forwarded to the Imperial Institute in 1907 was found to be of promising quality. Recent experiments on the Government Farm at Batkanu have given good results and considerable interest has been aroused among the chiefs and the people of the district. Trials are also being conducted at the Njala Experiment Station, and a simple form of machine has been erected for extracting the fibre.

Gold Coast.—An interesting experiment in Sisal growing is now being carried out by the Government of the Gold Coast. During the German occupation of Togoland large plantations of Sisal hemp were created, two of which subsequently came under British administration. These plantations proved so successful that in 1920 it was decided to plant an area of 1,000 acres on a site a few miles west of Accra with the object of demonstrating that the dry plains at present lying waste in this region can be profitably cultivated. The plantation is intended to serve as the centre of an industry which it is hoped will be adopted by the native farmers as soon as they have appreciated the value of the crop. A central factory has been erected and equipped with modern fibre-extracting machinery. The Government are under agreement with the local chiefs to hand the plantation and machinery over to them when the capital outlay has been recovered and when they have proved themselves competent to carry on the enterprise.

The climatic and other conditions of the district seem to be well suited to the crop as the plants have grown satisfactorily and present a healthy appearance. It was anticipated that leaves would be ready for cutting during the present year (1924). The local farmers are being encouraged to plant Sisal hemp, especially in the neighbourhood of the Government plantation, and advice and assistance are being freely afforded to them. As an additional inducement, the Government are planning a series of tramways radiating from the central factory with a view to facilitating transport of the leaves from the native farms. There are many miles of country suitable for the cultivation and it is hoped that an extensive industry may eventually be created.

Sisal hemp has also been grown experimentally at the Tamale Agricultural Station in the Northern Territories and at other agricultural stations, and successful results have been obtained.

Union of South Africa.—Comparatively little attention has been devoted to Sisal hemp in South Africa, although the Mauritius hemp plant (*Furcraea gigantea*) has been grown on a small commercial scale in Natal.

Trials made with Sisal hemp in the Union have indicated that the most suitable situations for plantations are lowlands near the coast, or waste lands at altitudes not exceeding 1,800 feet—where the atmosphere is warm and humid and where only slight variations in temperature occur.

A survey of the coastal districts with reference to the possibilities of establishing a fibre industry was made in 1917 by Mr. E. Holmes-Smith, B.Sc., at the request of the Secretary for Agriculture. The results indicated that, in general, the whole of the coastal area from the Transkei to Mossel Bay offers great possibilities for Sisal cultivation, and it was suggested that experimental plantations should be made in the vicinity of Kei Bridge (Transkei), East London, Kingwilliamstown, Port Elizabeth, Uitenhage or Humansdorp Districts, Knysana, and George. Abundant supplies of water and fuel, cheap labour and ready means of transport are available at all these places.

South-West Africa.—Trials in Sisal hemp cultivation are now being made in the mandated territory of South-West Africa, and a sample of fibre grown at Rietfontein on the border of Bechuanaland has recently been received at the Imperial Institute and found to be of good quality.

Rhodesia.—In Northern Rhodesia there are large areas in which the soil and climatic conditions appear to be favourable for Sisal hemp cultivation and which offer good opportunities for the production of the crop on an extensive scale. In 1912 trials were carried out at the Chilanga Experimental Gardens and at Mazabuka. The plants grew well and the leaves gave a satisfactory yield of fibre. A sample of the fibre produced at Chilanga was received at the Imperial Institute in 1917 for examination and was found to be rather short but otherwise of excellent quality.

Experiments have also been made in Southern Rhodesia but have not given very encouraging results. Although the plants grew fairly well, the leaves developed rather slowly and did not become sufficiently large to yield a fibre of good length.

India.—The production of Sisal hemp in India has not assumed important dimensions although attempts to cultivate the crop on a commercial scale have been made in Assam, Bombay and Southern India, and fibre has been extracted from plants growing beside the Railway in Coimbatore District, Madras. In the Central Provinces, *Agave Cantala*, the source of the "maguey" fibre of the Philippines, a product resembling Sisal hemp, is grown to some extent as a hedge-plant but comparatively little fibre is extracted. During recent

years some attention has been given to Sisal hemp in Burma, but no large quantities of fibre have yet been produced.

In Mysore several species of Agave are planted as hedges, but these are not of much value as a source of fibre. The true Sisal hemp plant was introduced in 1892 and has been cultivated to some extent in the Lal Bagh Gardens in Bangalore. Efforts are being made to grow the crop on a commercial scale in Mysore, but no results of importance have yet been obtained. Just outside the borders of the State in Coorg, however, a small plantation of Sisal hemp has been worked successfully for several years.

Ceylon.—Sisal hemp was grown for several years by the Department of Agriculture of Ceylon at the Maha Iluppallama Experiment Station in the North Central Province and satisfactory results were obtained. In 1918 this Station was closed, but with a view to continuing the experiments and extending the cultivation a syndicate was formed which was granted a concession of 2,200 acres of Crown Lands on special terms. Work was started in 1919 and good progress has been made. Fibre of excellent quality has been produced, and it is considered that with the introduction of efficient machinery a product will be obtainable on a commercial scale which should compare favourably with that from any other source. From the results obtained at Maha Iluppallama it has been estimated that the cost of production of the fibre should not exceed £10 to £12 per ton. There are good grounds for anticipating that the enterprise will be fully successful and, if such should be the case, it is probable that the industry will undergo great expansion as there are vast areas available in the dry zone of the Colony which are at present uncultivated and would be quite suitable for Sisal hemp.

The Agricultural Department is convinced that Ceylon offers great possibilities for fibre production, and since 1918 has had areas of Sisal under cultivation at Anuradhapura, where a small mill has been established for extracting the fibre. The Department is also undertaking small experimental trials at Jaffna and Hambantota, in the extreme north and extreme south of the island respectively. Large numbers of plants have been distributed mainly to the Southern Province and the Kurunegala District of the North-Western Province.

Federated Malay States.—There is no doubt that Sisal hemp can be grown satisfactorily in the Malay Peninsula. The Department of Agriculture have grown the plant experimentally for some years and recently interest has been taken in the crop by planters, and it is now being cultivated on a small scale on three estates. The necessity of growing the crop on a sufficiently large scale to justify the introduction of modern extracting machinery has hitherto militated against the establishment of the industry on commercial lines.

North Borneo.—The climate and soil of North Borneo are admirably suited to Sisal hemp cultivation, and some of the comparatively dry areas in the interior near the terminus of the railway are particularly favourable for the crop. Hitherto the plant has been grown only on an experimental scale, but it is considered that the country offers excellent possibilities for the establishment of a successful fibre industry.

Bahamas.—The Sisal hemp plant has long been acclimatised in the Bahamas, but was not seriously regarded as worthy of systematic cultivation until 1888, when the Governor of the Islands (Sir Ambrose Shea) took steps to encourage the establishment of a local fibre industry. During the next few years several large undertakings purchased extensive tracts of land and planted them with the Sisal agave. The rapid growth of the industry is shown by the following data of the quantities and value of the fibre exported in certain years :

Year.	*Quantity tons.*	*Value. £*	*Year.*	*Quantity. tons.*	*Value. £*
1891	9	149	1912	3,600	66,427
1892	30	692	1915	3,453	72,601
1893	52	1,200	1916	3,739	114,465
1894	79	1,728	1917	3,349	181,695
1895	242	3,987	1918	2,607	128,564
1897	402	4,522	1919	2,830	85,131
1899	607	16,942	1920	1,940	51,329
1903	1,439	38,805	1921	108	2,242
1906	1,726	40,140	1922	1,156	23,000
1909	2,610	48,805			

The whole of the fibre exported from the Bahamas enters the United States.

In 1917-18, as a result of the increased prices due to the war, the plantations were considerably extended. In 1918 a system of grading of the fibre was introduced and a special Inspector was appointed. The packing houses have co-operated with the Inspector and there is no doubt that the grading has led to an improvement in the standard of the hand-cleaned fibre. In 1921 the American demand ceased for the greater part of the year and export was suspended. During 1922, however, all the stocks which had been stored were disposed of and the industry exhibited signs of renewed activity.

The production of Sisal hemp has proved of much value to the Bahamas, and, owing to the resistance of the crop to drought, it has been of great financial assistance to the people at times when other crops have failed.

Cayman Islands.—The Sisal hemp plant grows readily in the Cayman Islands and a few years ago consideration was given to the possibility of creating a local fibre-growing industry. It was soon realised, however, that development was precluded by the high price of suitable land and by the impracticability of obtaining the necessary labour at a reasonable cost.

(To be concluded.)

NOTES ON COTTON STAINER CONTROL.

By C. L. Withycombe, Ph.D., D.I.C.

Before embarking upon the introduction and cultivation of any crop in a new country one has to consider, as far as is possible, not only the suitability or otherwise of the climate, soil, labour, &c., but also the prevalence and likely influence of indigenous pests and diseases upon the production of such a crop. One has always to bear in mind the fact that in clearing land and planting a new crop the natural balance may be upset to a considerable degree and it is very difficult to foresee the consequences of such action.

It is in somewhat this position of uncertainty that we now find ourselves placed with regard to cotton. New lands for cotton cultivation must be found, largely owing to the ravages of various insect pests in the present cotton-growing countries, for example especially the Mexican boll weevil in the United States and the pink boll worm elsewhere. There remain, however, other pests which are almost equally important.

In all parts of the tropics and sub-tropics are found certain plant bugs belonging to the genus *Dysdercus* and known commonly as cotton stainers. These bugs, in their natural state, live upon various wild Malvaceous plants but will readily leave this food in preference for cotton, which also belongs to the same plant group Malvaceae. They have therefore always been associated with cotton and the popular name of stainer has been bestowed upon them from the fact that the lint of cotton bolls after puncture by these bugs is often found to be stained and rendered useless for commercial purposes. Nowell has shown that the staining is caused by several internal boll fungi and bacterial rots the spores of which are transmitted by the bugs when puncturing the cotton bolls for food.

The actual damage caused by the bug sucking nutriment from the cotton boll is without doubt important and experiments prove that the presence of cotton stainers is associated with a much higher percentage of shedding of the young bolls than is normal in non-infected plants. This direct damage is, however, totally eclipsed by the wholesale destruction wrought by internal boll rots, and it is for this last reason that the cotton stainer assumes such importance.

For the past year the writer has directed his attention to the study of cotton stainers in Trinidad, with a view to finding some effective control measures. The present note is merely preliminary outline of certain more general results. In Trinidad cotton is grown only upon an experimental scale, but it is probable that results obtained under conditions here will be in many respects similar to those which would be obtained in other parts of the world, owing to the uniformity of life cycle and habits of these bugs.

As has already been mentioned, stainers can continue feeding and breeding upon various wild Malvaceous plants when cotton itself is not available and therefore one obvious method of control is to destroy wild food plants as far as possible in order that, in the close season for cotton, no food shall be accessible to the bugs, which should then die of starvation. This method is already in practice in several places and it is found to meet with a fair degree of success, but it is not always very practicable.

Observations in Trinidad, referring especially to *Dysdercus howardi*, show that stainers usually appear upon cotton when the bolls are ripening, and not before. This observation itself is by no means a new one and many previous investigators have recorded similar occurrences in other parts of the world, but its full significance seems to have been somewhat overlooked. Thus it is suggested by some that the absence of stainers prior to the development of the bolls shows that the bugs cannot derive sufficient nourishment from the cotton sap alone but that they must have access to the seeds to breed successfully. While not denying that there is some truth in this suggestion yet the main point to which attention should be directed seems to be that stainers are not attracted in any numbers to cotton until the bolls are opening.

The writer's observations show that individual cotton plots or fields remain practically, and often completely, free of stainers until the bolls commence to open. Directly this happens an influx of stainers follows which is composed entirely of adults and of which a certain percentage are peculiar, as will be mentioned later. The insects have migrated to the cotton in response to a definite attraction which the cotton now exerts. Further enquiry shows that this attraction is due to an odoriferous substance which is given off from inside the boll and which is most effective when newly exposed, *viz.*, when the boll first opens. Attempts to isolate this attractive substance have met with some degree of success but it has not been possible as yet to determine its exact nature. It is quite probable that the whole cotton plant contains small quantities of the same substance distributed throughout but it is certainly concentrated in the boll and as a result the opening bolls are most attractive. Apparently the same thing holds for other Malvaceous plants, opening ochra pods having also been found to be highly attractive.

We now therefore know the reason for the sudden appearance of the stainers; they have been attracted from elsewhere and are to be regarded as migrants which have apparently flown from localities near by where conditions were presumably less favourable. The latter part of this statement is made tentatively. In support of it may be stated, firstly, that stainers have been observed to fly frequently, although not more than twenty or thirty yards at a stretch in the daytime in Trinidad. But it is more probable that the insects generally migrate after sundown. In other West Indian Islands longer

flights have been observed, and in the daytime. Young stainers, which are wingless, have not been observed among the migrants on cotton and undoubtedly do not migrate.

As regards the second point above-mentioned, that migration occurs from less favourable localities, it is known that stainers will leave localities where climatic or food conditions have ceased to be favourable, and unfavourable conditions seem to induce a migrating disposition in *Dysdercus*. If the migrants to cotton are examined they will be found often to consist largely of small, or dark-coloured, or otherwise non-typical forms. The production of these varieties does not seem to be subject to the ordinary Mendelian laws but all breeding experiments point to their being produced by environmental conditions. On this point work is still in progress and it is in consequence not possible to give positive data, but as yet no peculiar "migratory" forms have been obtained when stainers have been bred upon cotton bolls under presumably good conditions, while, on the other hand, the writer has succeeded in producing "migratory" forms by breeding from typical, pale, large *Dysdercus howardi* under what were calculated to be unfavourable conditions. Further evidence in support of the above assertions will be published later elsewhere; such is hardly within the scope of the present note.

Peculiar varietal forms which seem also likely to be correlated with environmental conditions have been noted in other parts of the world. Thus *Dysdercus discolor* (=*delauneyi*) of St. Vincent has a light-coloured form which may be of this nature. Several Nigerian species, *melanoderes*, *nigrofasciatus* and *intermedius*, seem likely, in the writer's opinion, to be merely forms of *D. superstitiosus*. Uvarov has shown similar varietal forms to be associated with locust migrations.

Summarising then the results of these preliminary investigations, it is seen that a newly planted cotton field, if sufficiently separated from sources of infection, will remain free of stainers until the ripe bolls commence to open. As soon as this occurs an influx of stainers will follow and henceforth these pests will continue to breed on the cotton until conditions cease to favour. The result on the cotton crop can easily be anticipated. The first pickings of bolls will yield a fair proportion of good and unstained lint, but subsequent pickings, of bolls which have developed under stainer conditions, will be of progressively less value.

In cultural counter measures, then, one obvious aim would seem to be to select and grow a heavy cropping cotton which will produce a large first crop of bolls, the return from which shall be sufficient to clear a good profit. Later pickings may be expected to be of little value and the plants should be destroyed as soon as possible. A different crop must be grown next on the same ground so that no further breeding of stainers can occur. Young stainers, which are wingless, cannot migrate far.

Each new cotton field should be situated at some distance from any source of infection. The cotton has been shown to be not very attractive to stainers until the bolls commence to open and it may be mentioned that at a distance of two hundred yards from an infected plot of perennial cotton at the local Government Experiment Station a good and unstained first crop of bolls from Sea Island cotton was obtained. Not a single stainer was observed on this field until the bolls ripened. This distance of two hundred yards may prove to be sufficient elsewhere, but the point must be decided by actual experiment. It would be well to plant at too great rather than at too small an interval.

Perennial cottons do not seem to be advisable under conditions such as have been described, although they might possibly be utilised if cut down and thoroughly cleaned up after each crop. Generally, however, they serve as breeding grounds for the stainers at a time when few bolls are being produced and no real crop can be obtained.

Whether these suggestions are practicable or not on a large scale, must await actual trial, but under the climatic conditions of Trinidad, at least, such would seem to be the only solution for cultural control if cotton is to be grown at a profit. It may appear drastic to destroy a cotton crop immediately after the first picking and to reap all profits from this, but in the opinion of the writer this should prove to be a sound economic proposition, troublesome though it may be. Mr. L. H. Burd tells me that in the St. Vincent Experiment Station all plants are destroyed after the first picking and as a probable result higher yields and greater freedom from stainers are obtained here than elsewhere in the island.

ALCOHOL FROM THE *AGAVE SISALANA* (SISAL).

[*This article has been translated from "L'Agronomie Coloniale," June*, 1924, *and is presented as likely to be of interest in connection with the need for sources of motor fuel supply and as giving facts useful for a possible development of a minor product in connection with the Sisal industry which is dealt with in the article on Fibre Production, the second part of which is to be found in this issue of "Tropical Agriculture."*]

It is some time since experiments made in different countries have proved that alcohol can be obtained from the juice of the *Agave sisalana*. Last year, Messrs. F. Bruno and F. Sorzes published in *l'Agricoltura coloniale* (XVII No. 5. pp. 161-169) "studies and research on the alcoholic fermentation of the sisal juice," their experiments being carried out at the Colonial Garden, Palermo, on the *Agave sisalana* which attains a vigorous growth in Sicily.

From leaves gathered in December, April and July, there was extracted (*a*) 48 to 50 per cent., (*b*) 52 per cent., (*c*) 50·8 per cent. of juice containing (*a*) 4·89 to 6 per cent., (*b*) 6·10 to 6·38, (*c*) 4·40 to 6·65 of dry extracts respectively. Leaves cut and pressed the same day gave the minimum of juice, the maximum being obtained from leaves kept in the shade and cut after eight days, this difference being due to concentration by evaporation (which eliminates 6 to 9 per cent. of water from the leaves) and to decomposition in the mass of leaves.

The density of the juice at 15° varies from 1·014 to 1·037 and contains 1·008 per cent. to 2·96 per cent. of sugar in the form of glucose.

Hérelle's observations that both density and sugar content increase when the juice is kept for some days was confirmed; these vary with the seasons and are higher in Sicily in plants gathered from August to the first days of December.

In the juice of plants cultivated on the spot and pressed in May, the *R. Ufficio Agrario* of Tripolitaine estimates density 15=1·0105, reduced sugar content, 1·358 per cent.; total sugar content 1·482 per cent. These results agree with those obtained by the writer.

The first difficulty to overcome in the alcoholic fermentation of the juice of *Agave sisalana*, is its strong acidity, the writers find that it is necessary to add 2 per cent. of calcium carbonate and 5 per cent. of ammonium phosphate; they have carried out this fermentation and have obtained from 5·5 to 6·1 cubic centimetres of anhydrous alcohol to each litre of juice.

The average weight of a leaf is 800 grammes; giving an average of about 400 grammes (50 per cent.) of juice; each plant bears 25 leaves corresponding to 10 litres of juice per year. From 2,000 plants to the acre 20,000 litres of juice would be obtained. If this contains 2·27 per cent. of glucose, the total yield of fermentable sugar per acre would be 454 kilogrammes, and this should provide 167 litres of alcohol.

FURFURAL.

PROFESSOR F. HARDY, M.A.

[*Furfural is a plant product of coming importance and its local manufacture may prove to be the means of more profitably utilising waste material in many branches of tropical agriculture.*]

The onward march of biochemical technology adds almost monthly to our list of commercially useful substances. One of the most promising of recent additions to this list is furfural, which, as the name implies, was first prepared from bran. Furfural is a colourless liquid, boiling at 162°C. It finds its chief employment as a solvent and germidice. Chemically, furfural is an aldehyde, resembling in this respect formaldehyde, whose aqueous solution (formalin), is one of the chief industrial antiseptics at present in use. Furfural, however, bids fair to rival formaldehyde, since recently it has been found possible to manufacture it on a large scale and at low cost from waste vegetable matter. Whereas in 1920, the price quoted for furfural was 30 dollars per lb., the substance is now being sold at 25 cents per lb. This remarkable drop in price is due entirely to the co-operation between research workers and manufacturers of plant products.

The story of furfural is clearly told in a series of publications to which reference is made at the end of this article. The main contribution to the development of the commercial manufacture of furfural has come from the United States Bureau of Chemistry. Earlier workers in the field of cellulose chemistry had demonstrated that corncobs, when treated with hot water under pressure, yield a valuable adhesive, together with varying amounts of furfural (1). Further experiments, planned with the definite idea of increasing the yield of furfural (2), indicated that the process might be developed into a paying commercial industry. This conclusion was amply confirmed by large scale trials (3, 4, 5, 6,) by which it was shown that a plant capable of handling 50 tons of corncobs per day could produce therefrom 9,000 lb. of furfural, at an estimated cost of 6·15 cents per lb. The success of such a venture depends, of course, on a regular supply of raw material of low price. This is realised in the great corn belt of the United States, and in certain other corn growing regions, such as the valleys of the Mississippi River Basin, where waste corncobs can be obtained at 2 to 3 dollars per ton (6).

Corn cobs are not the only fruitful source of furfural. Indeed, almost any vegetable matter that contains the gummy substances known as pentosans, on treatment with boiling water or steam, especially at high pressure and in the presence of a trace of acid, gives furfural. The chemical change that proceeds is known as hydrolysis; pentose sugars are formed as intermediate products. Among the many waste vegetable materials that contain pentosans, may be mentioned the following tropical examples:—corn stalks, banana stalks, cotton seed hulls, sugar cane megass, kapok waste, and saw dust. These contain different amounts of pentosan, however, and are not equally valuable as sources of furfural. Thus, Farnell (8) found that sugar cane megass may contain as much as 25 to 31 per cent. of pentosan, which agrees with the earlier results of C. A. Browne and of Geerligs. Pervier and Gortner (9) found 15 per cent. of pentosan in a sample of pine sawdust, and Ritter and Fleck (10) found percentages varying from 6 to 23 in the wood of various North American trees. These figures should be compared with the pentosan content of corn cob, which is usually about 35 per cent. (3). The investigation of the pentosan contents of other vegetable wastes awaits further attention.

The industrial uses of furfural are numerous and varied (11). Recently, there has been an active interest taken in the preparation of tarry resins from furfural by treatment with alkali, and of hard resins by combination with phenols. These latter derivatives find great use in the manufacture of gramaphone records, which formerly were made almost exclusively from phenol-formaldehyde compounds. As a fungicide and insect repellant, furfural can be used in place of formaldehyde. As a solvent of varnishes and cellulose esters, it has great possibilities. At least two valuable dye-stuffs can be obtained from it, and a new anaesthetic derived from furfural is being carefully tested. In the rubber factory, furfural may be used as an accelerator in vulcanisation, and on the rubber estate as a bactericide for preserving latex. Finally, furfural burns slowly with a luminous flame, and finds use as a fuel for certain purposes. According to La Forge (6), a market for several million pounds of furfural per year is doubtless forthcoming in the near future.

In addition to furfural, the simultaneous production of pentosan adhesive and of valuable cellulosic material which finds use in paper manufacture (7), as well as of certain organic acids renders the preparation of furfural from vegetable waste a highly practical and economical process. It is to be hoped that tropical chemical technologists will take note of the possibilities of this promising new industry.

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(7) *Ibid.*, 1924, Vol. 16, No. 2, p. 130, "The simultaneous production of pentosan adhesive and furfural from corncobs and oat hulls," F. B. LaForge.

(8) *Intern. Sugar Journ.*, 1923, Dec., p. 630, "Pectic substance of Sugar Cane Fibre."

(9) *Indus. Engin. Chem.*, 1923, Vol. 15, No. 11, p. 1167.

(10) *Ibid.*, 1923, Vol. 15, No. 10, p. 1055.

(11) "Commercial Furfural, its properties and uses," pamphlet, sent free on request, by the Miner Laboratories, 9, South Clinton Street, Chicago, Ill., U.S.A.

COLLEGE NEWS.

At a regular meeting of the Agricultural Society of Trinidad and Tobago, Professor H. A. Ballou read a paper entitled "Some relation between crop plants and their insect pests."

Professor F. Hardy read a paper on "Soil Acidity" before the Trinidad Horticultural Club at its regular meeting on September 11. Professor Hardy demonstrated the methods by which the acidity of soils may easily be tested, and referred to the different requirements of various kinds of plants.

Dr. S. C. Harland read a paper before the Tunapuna Branch Agricultural Society on September 18. The subject was "Poultry Keeping in the West Indies."

Professor S. F. Ashby returned to Trinidad from St. Lucia on September 12, where he had been to inspect the developments being made in the banana industry in that Island and to advise with regard to the prevention of Panama disease.

Professor W. R. Dunlop, who recently resigned his position of Professor of Economics in the College, left Trinidad on September 12, by the S.S. *Venezuela* for the United Kingdom.

Mr. Cecil Y. Shephard has been appointed Professor of Economics, *vice* Professor Dunlop. Mr. Shephard will also be in charge of *Tropical Agriculture*.

The Empire Cotton Growing Corporation has granted scholarships at the College to six students who are to do post-graduate work in connection with cotton cultivation.

There are, in addition to these, two other Post Graduate Students who are interested in agricultural investigation and research.

At the time of going to press the Diploma Students have not arrived in Trinidad. It is expected, however, that the numbers of students in the several years will be:—Third year 8, Second year 4, First year 8.

Dr. C. L. Whittles, B.A., Ph.D., called at the College on August 26, on his way to British Guiana, where he has recently been appointed to the post of Scientist in charge of Sugar-cane experiments to the British Guiana Growers' Association. Dr. Whittles showed a keen interest in the work now going on in the Soil Science Department of the College.

Mr. Preston E. James of the Department of Geography, University of Michigan, U.S.A., visited the College on several occasions in the early part of September for consultation on matters concerning economic and soil problems. Mr. James is engaged in a regional geographic survey of Trinidad, as part of his wider researches on tropical economic and social geography.

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR.—During September sugar has been in better demand and for Cubans, duty paid, New York, $6.75 may be taken as a basis.

COTTON.—Fully middling, Liverpool, has been steadily declining in value since the end of July and the basis for the middle of September may be taken at 15½*d.* per lb.

CACAO.—Firmness in the cacao market is being maintained with Trinidad at $12.00 locally. Accras, in London in mid-August, were selling at 31*s.* per cwt. with Trinidad mid-red at 52*s.* 6*d.*

COFFEE.—Prices for this product continued firm during August and September reaching the high price of 123*s.* per cwt. for washed Sao Paulo, August 21.

TEA.—Active competition for the higher grades continues, the Indian Average being about 19*d.* per lb.

SISAL.—Prime Sisal has risen steadily since November and values after showing some decline during June and July became firm again towards the end of August, £45 per ton, East African being particularly in demand at good prices.

RUBBER.—An improvement in the demand has taken place, the level of 1*s.* 1*d.* being maintained in the beginning of September.

RICE.—The rice market has been quiet with Burmese around £16 per ton.

COPRA.—The price of prime Copra has been rising again after the May dullness and during August was at the relatively high figure of £31 per ton. Dessicated coconut, firm (August 22) fine cut, spot, quoted 41*s.* per cwt.

VEGETABLE OILS.—Palm kernels were steady at the end of August selling at £21 per ton *ex quay* terms, Liverpool. Crushed palm kernel oil, £42 per ton and crushed extracted ground nut, £48 10*s.* (Hull).

SPICES.—Black Singapore pepper, 5*d.* per lb.; Zanzibar cloves, 1*s.* per lb.

BOOK REVIEWS.

HANDBOOK OF THE LEEWARD ISLANDS.—This book has been compiled by Mr. F. H. Watkins, I.S.O., and is published by authority of the Government of the Leeward Islands, by the Crown Agents for the Colonies and bears the *imprimé* of the West India Committee.

This handbook in addition to being attractive in its form and make-up, will be found to contain complete and interesting accounts of the Leeward I lands. The contents of its 300 pages include historical sketches of the islands of the group with accounts of the development of agriculture and Government institutions, the origin and increase in population, and the various viscissitudes through which they have passed from drought, hurricanes and wars. The descriptive sketches indicate the geographical, geological, meteorological and scenic features of each of the islands, with accounts of the special agricultural outlook in each case. The sections devoted to the Imperial Department of Agriculture, Botanic Stations and Agricultural Activities give an account of the development of the various agricultural industries in the several islands; including sugar, cotton, lime and cacao, and several minor products.

The handbook will prove a source of interesting and useful information on the general administration of these islands, and it should be particularly useful to all who intend visiting them either for pleasure or business purposes.

MALAYAN AGRICULTURE.—This handbook has been compiled by the Department of Agriculture, Federated Malay States and Straits Settlements for distribution at the British Empire Exhibition, 1924. It gives a general account of the agricultural conditions in Malaya, with special consideration of each of the major and minor crops, with notes on pests and diseases and their control, and also with notes on domestic cattle and poultry. The article on " Pineapples in the Straits Settlements " which appears in this issue of *Tropical Agriculture* at page 150, has been taken from the handbook, and will serve to indicate the useful character of the information which it provides. In addition to the accounts of the established crops, of which rubber, coconuts and rice are the most important, the handbook indicates several minor crops which may be developed and the general way in which this can be accomplished. It would appear that certain crops which should be suitable for development in Malaya are not likely to be taken up because of a shortage of suitable labour. This would apply to sugar-cane and tea. The minor industries are best suited to native agriculture, for the improvement and development of which education in the form of practical instruction in cultivation and marketing, and financial aid are said to be necessary. The Department of Agriculture is giving attention to the instruction of natives, while the organization of native industries will have to be dealt with by the Government Co-operative Department. This handbook may be used as a textbook on Malayan agriculture. It is well printed and illustrated on good paper, and should be found useful to everyone interested in tropical agriculture.